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GEOLOGY AT ILLINOIS

DEPARTMENT OF GEOLOGY NEWSLETTER
SPRING 1976 ✢ ✢ ✢ ✢ ✢ ✢ ✢ ✢ ✢ ✢

To Alumni and Friends of the Department:

With this issue the NEWSLETTER of the Department of Geology takes on a new look — and a new frequency. Rather than the single annual issue to which you no doubt have become accustomed, we hope to provide you with fall, winter, and spring issues annually, each containing articles and information of current interest about the department and its alumni. If you have items you consider appropriate for the NEWSLETTER, we would appreciate your bringing them to our attention. Please send the information either to me or to the departmental secretary, Mrs. Ellen Abell. We hope that you find this Spring 1976 issue of interest, and we always welcome your suggestions.

Fred A. Donath, head

A NEW LOOK AT CARBONATES

Staff members at Illinois are taking a renewed and intensified interest in carbonate studies. The diverse specialties of the staff are being pursued through a broad range of research projects. Emphasis presently is on combining the areas of paleontology, carbonate petrography, and experimental geology to better understand the original skeletal states of organisms and to decipher the diagenetic processes which have affected limestones. Geochemistry has also recently been brought into this picture, since the study of minor elements and isotope composition often provides support for the textural studies.

The department is unusually well equipped for carbonate studies. In addition to a mass spectrometer and sophisticated high pressure equipment that simulates natural environments, the department can make use of its instructional tabletop scanning electron microscope (SEM). Research projects involving several faculty and students are combining microprobe and isotope (carbon and oxygen) analyses with SEM and petrographic studies of carbonates.

The high magnifications and great depth of field afforded by scanning electron microscopy allow detailed examination of specimens at a scale never before possible. This capacity has led to the detection of features or relationships in carbonates which were previously overlooked or misinterpreted. For example, using an SEM in studies of skeletal diagenesis Professor P. A. Sandberg has discovered relic original aragonite crystallites as solid inclusions in what was previously thought to be pure calcite replacing original skeletal material. These relics provide unequivocal evidence of original aragonite mineralogy and demonstrate that replacement occurred without void development and collapse of the original ultrastructure. In addition to comparative SEM and experimental studies of alteration in skeletal and nonskeletal carbonates, Dr. Sandberg is studying the origin and diagenesis of ooids.

Directing their attention to a different aspect of carbonate diagenesis, Drs. Carozzi, Donath, and Fruth and

Dr. Sandberg and the teaching assistants for the undergraduate courses in paleontology and stratigraphy (Mark Reinbold and Sophie Dreifuss) engaged in a training session on the department's SEM. In addition to its use in formal undergraduate courses, the SEM has been used in a number of senior thesis projects, and is available for use by other, suitably trained individuals in the department.

several graduate students have embarked on a study of permoporosity development in oolitic and other limestones using specially designed high pressure equipment in which circulating solutions and other conditions of the natural diagenetic environment can be simulated. They seek to understand the processes and conditions which lead to significant secondary porosity in limestone reservoir rocks that are tightly cemented before burial. Initial results have provided understanding of the development of oomoldic porosity in the Mississippian Ste. Genevieve limestone of Illinois.

WORK ON CLAYS REVIVED

With the arrival in the department this year of Professor Dennis D. Eberl (Ph.D., Case Western Reserve), clay studies are undergoing an exciting revival. Professor Eberl is offering an advanced course in clay mineralogy structured as a series of seminars, not unlike those offered by Professor R. E. Grim several years ago. Representatives from various disciplines throughout the campus, such as Ceramic Engineering, Soils Engineering, and the State Geological Survey, are invited to participate.

Dr. Eberl is checking temperature variations of hydrothermal bombs employed in synthesis of clay minerals.

Research is centering on the petrology of clay minerals with two main areas of emphasis: the hydrothermal synthesis of clay minerals, and determination of the origin of natural deposits. Laboratory duplication of natural assemblages is being attempted in order to determine how clays are formed. Clays with special properties are also being created. Such specialized clays may be used for the catalytic conversion of hydrocarbons to oils or for removing pollutants from water. Professors Eberl and Donath are working on experimentally duplicating diagenesis in clays, such as that which occurs naturally in the Gulf Coast area. A better understanding of this process will lead to more profitable oil prospecting and drilling.

Discoveries made from the study of the crystal chemistry of clays may be applied to some very practical problems in the future. Clays may be created to absorb heavy metals, thus purifying landfill water; to absorb cations (e.g., sodium), allowing the desalination of sea water; to alter kaolinite and increase bonding properties in paper coating processes; to increase the cation exchange capacities in tropical soils, thus aiding agriculture in underdeveloped countries; and to alter clays which interfere with the success of engineering and construction projects.

HAL WILLIAMS HARDINGE AWARD

Haydn H. Murray '48, M.S. '50, Ph.D. '51, chairman of the Department of Geology at Indiana University since 1973, is this year's recipient of the Hal Williams Hardinge Award. He held the Illinois Clay Products Fellowship in clay mineralogy in 1949 and 1950, and in 1951 accepted a joint appointment at Indiana University as assistant professor of geology and as clay mineralogist for the Indiana Geological Survey. From 1957 until 1973 he held various positions with the Georgia Kaolin Co., including director of research, manager of operations, vice-president of operations and executive vice-president of the company. He has published some fifty papers and holds two U.S. patents.

HYDROGEOLOGY DIVISION OFFICERS NAMED

University of Illinois alumni provide strong representation in the Hydrogeology Division of the Geological Society of America for the current year. Officers include First Vice-Chairman, Paul A. Witherspoon, Ph.D. '57, University of California, Berkeley; Second Vice-Chairman, John D. Bredehoeft, M.S. '57, Ph.D. '62, U.S. Geological Survey, Reston, Virginia; and Secretary-Treasurer, John A. Cherry, Ph.D. '66, University of Waterloo, Ontario.

1975 MEINZER AWARD GIVEN

The 1975 Meinzer Award panel, consisting of Leonard Wood, chairman, and George Davis, Robert Schneider, Eugene Simpson, and James Slosson, has designated John D. Bredehoeft, M.S. '57, Ph.D. '62 and George F. Pinder, Ph.D. '68 as recipients of the 1975 award for their paper "Mass Transport in Flowing Groundwater" (*Water Resources Research,* 1973, vol. 9, no. 1, pp. 194-210).

Among alumni recently on campus to review developments in geology were, from left Lloyd Harris, Mattoon, Haydn Murray, Bloomington, Indiana, and Max David, Midland, Texas, with Dr. Fred Donath, right, department head.

ALUMNI ADVISORY COUNCIL PLANNED

Plans for an alumni advisory committee for the Department of Geology were developed at a recent two-day conference of representative alumni and staff members on the Urbana-Champaign campus. Under the guidance of Fred A. Donath, department head, the geologists toured facilities, met with faculty, and heard about recent programs and hopes for the future.

Alumni participating in the sessions were: James R. Baroffio, Ph.D. '64, vice president for exploration research of Chevron Oil Co., La Habra; George V. Cohee '31, M.S. '32, Ph.D. '37, chairman of the geologic names committee of the U.S. Geological Survey, Washington; Max David '35, M.S. '36, Midland, Texas, and Lloyd A. Harris '39, Mattoon, independent oil producers.

Morris W. Leighton '47, chief geologist, Esso Inter-America, Inc., Coral Gables, Florida; Haydn H. Murray '48, M.S. '50, Ph.D. '51, chairman of the Indiana University Department of Geology; and Jack A. Simon '41, M.S. '46, chief of the Illinois State Geological Survey, Urbana.

The group recommended that the council include twelve alumni and that it meet annually on the Urbana-Champaign campus in October. Nominations for membership on the council would be welcome and should be sent to Professor Donath.

K. O. EMERY HONORED

Kenneth O. Emery '37, M.S. '39, Ph.D. '41, was presented the 1975 American Association for the Advancement of Science Rosenstiel Award in Oceanographic Science at the society's annual meeting in Boston. Dr. Emery, Henry Bigelow oceanographer at Woods Hole Oceanographic Institution, was cited for outstanding research on continental margins and marginal seas of the world. In addition he was honored for "an unparalleled record" in training many of today's leading marine geologists.

Much of the scientist's past fourteen years have been spent in the exotic waters of the China and Java seas, the South Pacific, or the western coast of Africa. Along with his work on the untapped energy resources under the seas he has studied the prehistory of the oceans, especially the birth of the Atlantic 160 million years ago when, scientists believe, the Americas and Africa drifted apart.

HELP US KEEP IN TOUCH AND SAVE MONEY —

Please bring to our attention any change of address and affiliation.

THE FACULTY

David E. Anderson. Metamorphic petrology: application of irreversible thermodynamics to metamorphic processes.

Thomas F. Anderson. Stable isotope geochemistry: genesis and diagenesis of carbonate sediments; kinetics and mechanisms of isotope exchange reactions.

Daniel B. Blake. Invertebrate paleontology and biostratigraphy: Paleozoic bryozoans and Cenozoic asterozoans.

Albert V. Carozzi. Sedimentary petrology and history of geology: statistical petrography and microfacies of carbonate rocks, carbonate diagenesis.

Carleton A. Chapman. Igneous petrology: origin of granitic plutons, ring structures, dikes, and layered masses.

Charles Collinson. Micropaleontology, stratigraphy and coastal zone geology: biostratigraphy of Paleozoic conodonts; Devonian and Mississippian stratigraphy.

Patrick A. Domenico. Hydrogeology: heat and mass transfer in porous media.

Fred A. Donath, department head. Structural geology and rock mechanics: mechanics of deformation, experimental studies of deformation and diagenesis.

Dennis E. Eberl. Clay mineralogy and petrology: clay synthesis.

Lester S. Fruth, Jr. Experimental geology and sedimentology: experimental rock deformation, compaction effects in diagenesis.

Donald L. Graf. Sedimentary geochemistry: studies of chemical sediments; crystalline structures and phase relations in aqueous systems; transport properties of clay-water systems.

Donald M. Henderson. Mineralogy: petrologic mineralogy, crystallography, and structural mineralogy.

Jon T. Holder. Solid state physics and geophysics: physical and mechanical properties of solids.

W. Hilton Johnson. Cenozoic stratigraphy and glacial geology: stratigraphy and mineralogy of glacial drift, Quaternary landscapes.

George deV. Klein. Sedimentology: tidal and deep-ocean sedimentation, sediment transport.

Ralph L. Langenheim. Stratigraphy and paleontology: stratigraphy and biostratigraphy of the western and middle Paleozoic, carboniferous corals, energy resource evaluation.

C. John Mann. Stratigraphy and mathematical geology: analysis of geological cyclicity and periodicity.

Alberto S. Nieto. Engineering geology: rock mechanics, slope stability, and hydroelectric projects.

Vytautas V. Palciauskas. Solid state physics and geophysics: equation of state, phase transformations, and transport processes.

Philip A. Sandberg. Micropaleontology, carbonate sedimentology: ostracodes and cheilostome bryozoans, ultrastructure and composition of invertebrates, diagenesis of skeletal and nonskeletal carbonates.

Dennis S. Wood. Structural geology and geotechtonics: quantitative analysis of strain in naturally deformed rocks, Lower Paleozoic of western Europe, Precambrian of Africa.

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DEPARTMENT OF GEOLOGY NEWSLETTER
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NEW PROGRAMS IN TRANSPORT STUDIES

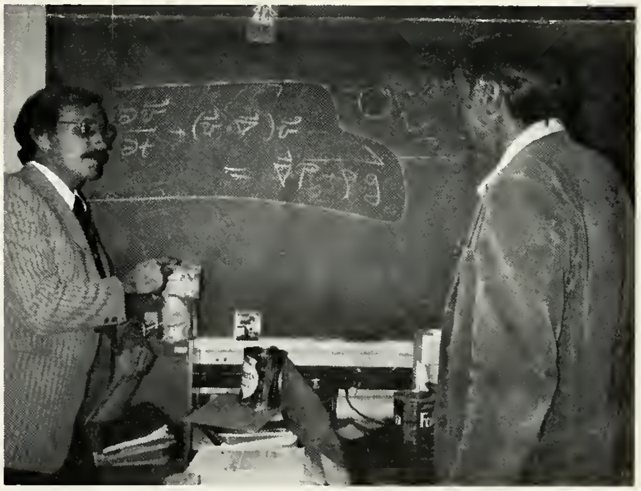
The Department now supports a strong program in transport studies, ranging from mass and energy transport in sedimentary environments to diffusion in metamorphic rocks. Using the same principles of thermodynamics and applied mathematics, several staff members are attempting to solve a variety of fundamental geologic problems. The study of transport phenomena is a basic and unifying approach to earth processes because it cuts across traditional specialty areas in geology such as metamorphic petrology, carbonate diagenesis, hydrology, geochemistry, geophysics, economic geology — even paleontology.

Several unique course offerings, reflecting the strength the Department has in this area, include a two-semester course in the mathematics of transport processes, a course in nonequilibrium thermodynamics in earth science, and a course in hydrogeology taught from a mass, energy, and momentum transport point of view. These are backed up by courses offered in the metallurgy and chemical engineering departments that are particularly useful to geologists.

The current research of Professor P. A. Domenico, a hydrologist, centers on dispersive and convective mass and energy transport in porous bodies, including the effects of these phenomena upon chemical rate processes, and salt water intrusion in aquifers in northern Mexico. The latter study is under the auspices of the International Bank for Reconstruction and Development. He and Professor V. V. Palciauskas, a geophysicist and applied mathematician, have recently published papers on mass transfer and the approach to chemical equilibrium in carbonate rocks, and on convective energy redistribution in shallow formations.

The transport of ions by diffusion is an important process in sediment piles undergoing diagenesis, lacustrine and oceanic water masses, deep basin brines, and the intergranular fluid present during metamorphism. Professors D. E. Anderson and D. L. Graf are engaged in a study of diffusion in aqueous electrolytes directed at estimating diffusion coefficients in the complex, multicomponent solutions found in nature, constructing models to describe diffusion in situations such as compacting sediment piles, and measuring diffusion coefficients in some ternary systems of geologic interest. Progress has already been made with simplifying and improving a quasi-kinetic model that allows diffusion coefficients to be estimated with reasonable accuracy from limiting ionic conductances. Because of the extraordinary difficulties associated with measuring diffusion coefficients in systems of more than three components, accurate estimation procedures are of vital concern to geologists and geochemists attempting to understand natural systems. Additionally, experience gained from aqueous electrolytes provides useful insight into the theoretical and experimental problems encountered in crystals and melts.

In another project supported by a separate NSF grant Professor D. E. Anderson is studying intercrystalline diffusion in metamorphic rocks. In the last ten years, the



Professors V. V. Palciauskas and P. A. Domenico reflecting on a fundamental relationship.

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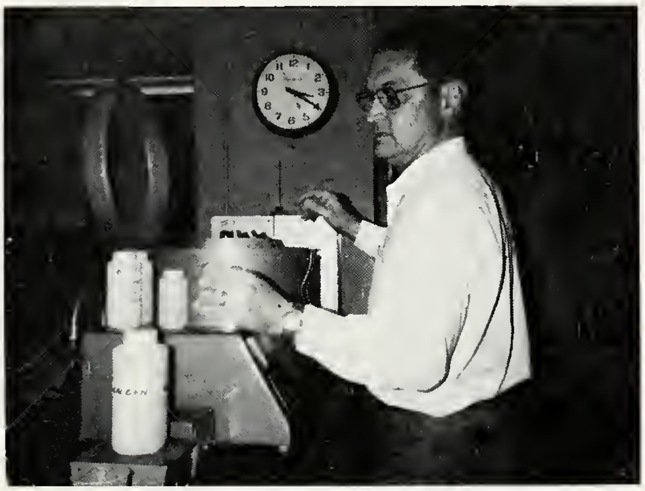
electron microprobe has revealed an intricate zoning of Fe, Mn, Ca, and Mg in most metamorphic garnets. The zoning contains important information about the physical and chemical history of the rock during metamorphism. Current work is directed at the systematic investigation of zoning in a suite of garnets from the Scottish Highlands, and the variation of the zoning with metamorphic temperature, rock composition, and coexisting minerals. From these data, it should be possible to analyze the roles of intergranular and intragranular diffusion during a metamorphic episode.

Professor D. L. Graf is also involved in developing diagenetic models that combine transport properties of the pore fluid with chemical reactions between the fluid and rock. Supported by grants from NSF and the U.S. Army Office of Basic Research, he is currently completing the construction of experimental apparatus to study the semipermeable-membrane behavior of shales at diagenetic pressures and temperatures, and x-ray cells to measure the amount of interlayer water in clays in contact with brine at typical subsurface temperatures and pressures. The semipermeable membrane behavior of shales plays a role in phenomena as diverse as landslides, the subsurface migration of petroleum and ore metals, and subsurface waste disposal. The information being obtained by Professor Graf and his students about cation adsorption and the amount of interlayer water in clays of the shales is needed to interpret the results of transport experiments.



Professor D. L. Graf loading up for another run on the centrifuge.

MACROPALEONTOLOGY THRIVES

Abundant fossiliferous Paleozoic rocks, excellent laboratory equipment, an outstanding University library, and important collections continue to make the University of Illinois an ideal place for the study of invertebrate paleontology.

In recent years, Professor Blake and his students have been involved with topics as diverse as Ordovician echinoderms, Devonian bivalves, Carboniferous communities, and the early stages of coal formation as evaluated through the study of microbiological activity in a modern peat bog.

Research in progress continues to be varied. Bryozoans are an abundant but generally neglected fossil group in many Paleozoic sediments. While Professor Blake is completing a revision of a bryozoan suborder, a new project is being initiated by a graduate student on the paleoecologic and biostratigraphic significance of bryozoans in certain middle Mississippian rocks. This project gains added importance because the rocks involved belong to a biostratigraphically difficult interval of the type Mississippian. Starfish, numerically important predators in modern marine communities, have generally left an incomplete fossil record, and thus their significance in ancient seas has been difficult to evaluate. In an attempt to provide new ways of looking at these interesting creatures, Professor Blake is studying the morphology of individual skeletal elements. These elements are complexly interconnected by soft tissues and articulation facets (much as in vertebrate bones), therefore an understanding of skeletal form and function is expected to contribute to the evaluation of even a scanty fossil record.

Professor D. B. Blake and assistant, Donita Brandt, making sample comparisons.

Paleontological research at Illinois is also coordinated with studies underway at the State Geological Survey. Dr. Dennis Kolata, Ph.D. '73, now employed at the Survey, and Professor Blake are in the early stages of evaluating certain widespread Middle Ordovician communities and environments in the upper Mississippi Valley. Large collections and great quantities of information available at the Survey contribute to the diversity of paleontological studies possible at Illinois.

FIELD CAMP YIELDS NEW MAP

The first comprehensive geological map of the eastern front of the Bighorn Mountains made since 1906 has been prepared by Professor Ralph L. Langenheim and two teaching assistants, Mark Reinbold and Stephen Tissue. The map covers a 200 square mile area of Wyoming. The data were gathered from 1967 through 1975 in work at the annual summer Geology Field Camp in Sheridan, Wyoming. Professor Langenheim said the map is of special interest because of the development of resources and land use in the Powder River Basin. The map has been published in a Guide to Geology of the Powder River Basin by the Wyoming Geological Association.

HANDS OVER WATER

Professor Thomas F. Anderson spent the 1975-76 year on sabbatical leave at two laboratories in Orleans, France, with support from the Centre National de la Recherche Scientifique (CNRS) and the National Science Foundation. A principal objective of the venture was to initiate a cooperative program on the application of stable isotope methods to problems of geological and chemical significance. At the Centre de Recherche sur les Solides a Organisation Crystalline Impairfaite (CRSOCI), Professor Anderson directed a study of the relationship of the chemistry and catalytic activity of synthetic zeolites to their oxygen isotope exchange kinetics. The study shows promise in defining the role of lattice oxygen in oxidative catalysis by molecular sieves. This work is continuing and will constitute the dissertation of a French graduate student at the University of Paris (Orsay). Professor Anderson also supervised the establishment of the facilities for the oxygen and hydrogen isotope analyses of silicates and water at the Bureau de Recherches Geologiques et Minieres (BRGM). These facilities will be used initially to investigate stable isotope relationships in metamorphism and hydrothermal mineralization in the Pyrennes. Both laboratories are interested in continued cooperation with the Department of Geology, both in terms of new research projects and in the exchange of personnel.

ALUMNI NOTES

Richard M. Winar, B.S. '53, M.S. '55, an associate in Dames & Moore's Chicago office, has been admitted to the firm's partnership. Dames & Moore, an environmental and applied earth sciences consulting firm, now has 93 partners in its 41 offices worldwide. Winar has participated on geological studies related to environmental planning and directed a number of site selection studies for nuclear and fossil fuel power plants and transmission lines. In addition, he has managed geological investigations for underground gas storage facilities, disposal wells, and numerous environmental studies.

Atlantic Richfield Company has appointed J. A. Savage, B.S. '50, vice president of exploration for the North American Producing Division, with headquarters in Dallas. In this position, Savage has staff responsibility for all North American exploration activities. He joined Atlantic Richfield in 1954 as a scout in the geological training program.

SIR KINGSLEY DUNHAM HONORED

During a recent brief visit to the Urbana area, Sir Kingsley Dunham, F.R.S., and Lady Dunham attended a tea and reception in their honor arranged by Dr. & Mrs. George White. Sir Kingsley has just retired as Director of the Institute of Geological Sciences in Great Britain. Under his directorship the Institute, which includes the Geological Survey, the Museum and the Overseas Surveys, greatly increased its emphasis on environmental geology and particularly the problems connected with increasing urbanization. In a country as small as Great Britain with relatively little undeveloped area, solutions to these problems are particularly important. In addition, he has been a long-time scientific advisor to the government of Great Britain and various English ministers, plus a world consultant in economic geology. He is currently serving as Foreign Secretary of the Royal Society. His achievements as an outstanding geologist and as an administrator of science and governmental advisor of the highest order led to his being knighted in 1972.

Sir Kingsley has been an invited lecturer at many universities, including several in Russia. His first association with the University of Illinois at Urbana was as a George Miller Professor in 1955-56. He also received an honorary degree of Doctor of Science from the University of Illinois in 1971.

SOME RECENT FACULTY PUBLICATIONS

D. E. Anderson and **D. L. Graf**, 1976, Multicomponent electrolyte diffusion: Ann. Rev. Earth and Planetary Sciences, V. 4, p. 95-121.

T. F. Anderson and **B. J. Giletti**, 1975, Studies in diffusion — II. Oxygen in phlogopite mica: Earth Planet. Sci. Lett., V. 28, p. 223-225.

D. B. Blake, 1976, Functional morphology and taxonomy of branch dimorphism in the Paleozoic bryozoan genus *Rhabdomeson:* Lethaia, V. 9, p. 169-178.

M. W. Hansen and **A. V. Carozzi**, 1976, Carbonate microfacies of the Monte Cristo Group (Mississippian), Arrow Canyon Range, Clark County, Nevada: Earth Science Bull., Wyo. Geol. Assoc., V. 7, n. 4, p. 13-54.

C. A. Chapman, 1976, Structural evolution of the White Mountain magma series, p. 281-300 *in* Studies in New England Geology, Lyons and Brownlow, eds.: Geol. Soc. America Memoir 146.

P. A. Domenico and **V. V. Palciauskas**, 1976, Solution chemistry, mass transfer and the approach to chemical equilibrium in porous carbonate rocks and sediments: Geol. Soc. Amer. Bull., V. 87, p. 207-214.

F. A. Donath and **D. S. Wood**, 1976, Experimental evaluation of the deformation path concept: Phil. Trans. Royal Soc. London, A, p. 187-201.

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D. L. Graf and **D. E. Anderson**, 1975, Properties of one-dimensional diagenetic models: Jour. Geology, V. 83, p. 331-348.

W. H. Johnson, 1976, Quaternary stratigraphy in Illinois status and current problems, *in* W. C. Mahaney, ed.: Quaternary Stratigraphy of North America: Dowden, Hutchinson, and Ross, Inc.

G. D. Klein, 1975, Depositional facies in Leg 30 deep-sea sediment cores, p. 423-442 *in* Initial Reports of the Deep Sea Drilling Project, V. 30, ed. by J. E. Andrews, et al.: Washington, U.S. Government Printing Office.

R. L. Langenheim, 1975, Gold and tungsten deposits in a part of the Sugarloaf District, Boulder County, Colorado: Earth Science Bull., Wyo. Geol. Assoc., V. 7, n. 3, p. 19-35.

C. J. Mann, 1974, Quasifunctional equations for Ste. Genevieve Limestone facies and lithology: Math. Geol., V. 6, p. 107-115.

V. V. Palciauskas, 1976, Lindemann's criterion and the melting of solids at high pressures: Jour. Phys. Chem. Solids, V. 37, p. 571-576.

P. A. Sandberg, 1975, New interpretations of Great Salt Lake ooids and of ancient non-skeletal carbonate mineralogy: Sedimentology, V. 22, p. 497-537.

D. S. Wood and **T. E. Tullis**, 1975, Correlation of finite strain from both reduction bodies and preferred orientation of mica in slate from Wales: Geol. Soc. America Bull., p. 632-638.

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To Alumni and Friends of the Department:

Over the past 18 months I have been deeply involved in matters affecting the development of nuclear energy, especially those related to radioactive waste management. In addition to the importance of this work to the national interest, it has opened up several important new areas of research, as well as employment opportunities, that will be of considerable benefit to students in the Department of Geology in forthcoming years. However, my deepening involvement in matters of radioactive waste management with its high frequency of travel has made it increasingly difficult for me to oversee administration of the department. My desire to contribute to the development of national nuclear policy and to develop certain new areas of geologic research, coupled with the fact that I see no likely decrease in my involvement in these activities in the foreseeable future, has led me to request that I be relieved of administrative duties in the department. It simply would not be possible for me to maintain these new activities while also serving as department head, and do justice to both.

At the present time I am on leave from the University and supported by the Nuclear Regulatory Commission to continue work on site suitability criteria and methodology for risk assessment that will be utilized in the licensing of nuclear waste repositories. Although, as you read this, I am no longer head of the department (Professor Sandberg is currently serving as acting head), I want you to know that it is my intent to remain in the department as a professor of geology and to contribute in whatever way I can to the continued growth of departmental programs.

My eleven years as department head have been challenging and rewarding. I feel that significant progress has been made in the development of several important new programs and that we have sustained the strengths of several outstanding previously established programs. Some of the new and some of the old are again represented in this NEWSLETTER, as has been done in recent issues, along with other items that we hope will be of interest to you.

In closing, let me take this opportunity to indicate to all alumni and friends my appreciation for their support of the department and its programs.

Fred A. Donath

CURRENT PROGRAMS IN STRUCTURAL GEOLOGY

Work in structural geology and tectonics in the department emphasizes field training and field applications at both undergraduate and graduate levels, but this work is closely supported by a very active high pressure experimental laboratory for work in rock deformation. Structural training is enhanced by the department's summer program in field geology which is held annually in the British Isles. Approximately 30 students attend, the majority of whom are from universities other than the University of Illinois. Although this program covers a wide range of geology, it does have a structural orientation and detailed structural mapping projects are undertaken in Wales and the highlands of Scotland. All

British Isles Field Camp (Geology 315) students. Taken near Oban, Scotland.

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graduate students in structural studies are expected to participate in this program at some stage.

There are currently ten graduate students in the department involved in structural and/or regional tectonic studies in North America and Europe. This comprises the largest graduate group in the department with seven students in doctoral programs and three in master's programs. Research projects in progress include the following:

1. Experimental studies of oolitic limestones as a means of evaluating the heterogeneity of deformation and the controlling effects of temperature, confining pressure, and rate of deformation.
2. Studies of the anisotropy of deformed rocks using acoustic velocity, magnetic susceptibility, and dielectric permittivity techniques.
3. The relationship between finite states of strain and geologic structure.
4. The relationship between strain history and subsequent fracture patterns.
5. Investigation of pressure solution as a major deformational mechanism.
6. Study of fracture patterns and structural control of stratigraphy in the Illinois Basin.
7. Investigation of a plate margin sequence of ophiolites, mélanges, and blueschists in the late Precambrian of the British Isles.
8. Regional study of mélanges and the establishment of unambiguous criteria for distinguishing between soft sediment deformation under the influence of gravity, tectonic deformation of unconsolidated, or partially consolidated materials and tectonic deformation of lithified sequences.
9. Textural studies in zones of high strain in the earth's crust.

The department's structural program is under the guidance of Professors Fred A. Donath and Dennis S. Wood. One of the strengths of the program is the extent to which collaborative research is carried out with other institutions. Of these, the University of California at Los Angeles and the University of Leeds, England, are particularly valuable associations.

A NEW LOOK AT SOLID EARTH GEOPHYSICS

The department has developed an active program in solid earth geophysics that is concerned with the microscopic behavior of geologic materials. Research studies underway encompass both theoretical and laboratory experimental investigations in attempts to understand better the physical processes that take place in the earth's core, mantle, and crust.

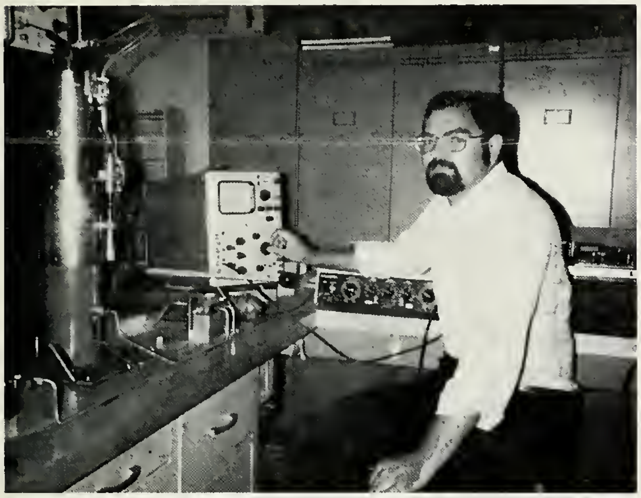
Course offerings in this area of geology include a senior-level introduction to geophysics, a graduate-level physical mineralogy course, and a seminar on current topics in solid earth geophysics. These courses are supplemented by a number of courses in the Departments of Metallurgy, Physics (which recently offered a course on the physics of planets), and Ceramic Engineering appropriate to training in solid earth geophysics.

One of the continuing areas of research by Professor V. V. Palciauskas has been the properties of materials at pressures and temperatures that exist deep in the earth's interior. Recent theoretical investigations have focused on the thermal properties of solids at high pressures, and have utilized a model interatomic potential for the prediction of thermal properties at pressures comparable to that of the mantle. Other investigations into the thermal state of the earth's deep interior have been approached through investigations of the melting of solids at high pressure. Utilizing the model interatomic potential and a melting criterion, calculations were performed to predict the fusion curves of some simple solids. The computation was a generalization of previous treatments and produced several novel results. The calculations have been applied to minerals believed to compose the upper and lower mantle and places additional restrictions on the possible temperatures in this region. The results were presented in an invited paper in a special symposium on the "Thermal State of the Lower Mantle" at the 1976 annual meeting of the American Geophysical Union. Work has recently been initiated toward the understanding of thermal instabilities with respect to convection.

The research program of Professor J. T. Holder is concerned with mechanical properties of materials and includes several projects sponsored by NSF through the University's Materials Research Laboratory (MRL). These are being carried out both in the MRL and in the laboratory of Professor Donath.

Special laboratory facilities have been set up in the MRL for the study of plastic flow in ice. In an investigation just completed, mechanical deformation experiments were designed to facilitate separation of the many different factors limiting flow within samples. Results of the study have led to development of a model describing the deformation in terms of the microscopic behavior of dislocation motion in ice. The model indicates that dislocation motion in ice is, in many respects, simpler than in other systems which have been studied. The plastic behavior of ice is perhaps now one of the best understood of all plastic materials. A current project is investigating additional details of the dislocation motion using optical observations of dislocation motion during deformation of samples that contain various types of impurities.

The study being carried out in Professor Donath's laboratory is an attempt to monitor deformation mechanisms with acoustic emissions that are generated during the deformation. Ultrasonic emissions in the 10 KHz to 1 MHz frequency range are detected by ceramic transducers attached to samples while these are deformed in triaxial testing apparatus; the signals are amplified and recorded for analysis. Various types of signals are correlated with mechanisms (such as grain microfracture, grain boundary sliding, and twinning) that are activated during the deformation by changing parameters such as material, deformation rate, confining pressure, and temperature. Experiments have been carried out on samples of limestone, sandstone, dolomite, and marble and they indicate that mechanisms can be identified according to the frequency, duration, and shape of the emissions. Acoustic emissions may ultimately provide a means for continuously monitoring the microscopic mechanisms that are active during the deformation of materials.



Ted Koelsch, research assistant for Dr. Holder, is monitoring the generation of acoustic emissions.

A third project, an experimental and theoretical study of the effects of nonhydrostatic stress on structural phase stability, has recently been completed. The comparison of calculated results for a simple ionic salt to the results measured in triaxial testing apparatus show that nonhydrostatic stresses have larger effects on phase stability than hydrostatic pressures. The detailed atomistic analysis possible with this simple system provides information regarding stability criteria for use in more complex systems and complement the more general calculations being carried out by Professor Palciauskas.

CONTINUING ACTIVITY IN ENGINEERING GEOLOGY

Following the successive departures within recent years of Drs. Don U. Deere (Ph.D., 1955) and Frank D. Patton (Ph.D., 1965) from the University for full-time consulting, the engineering geology program became the responsibility of Professor A. S. Nieto (Ph.D., 1974). Today, the program continues actively to train both national and foreign students. Close coordination between our engineering geology program and the geotechnical program in the Department of Civil Engineering permits a blend of applied geology and engineering knowledge to be imparted to students of both programs. This has proved very effective in practice and our graduates are actively sought by industrial concerns.

It is expected that the development of the program will continue to reflect the increasing worldwide demand for properly trained engineering geologists, and that our graduates will contribute vitally to the solution of problems in surface and subsurface mass transportation, environmental impact, and exploitation of alternate energy sources.

The research of Professor Nieto is centered around the shear strength of rock and soil masses. Two recently completed projects are a study of shear strength of clay seams in rock masses and an investigation of the dependence of en echelon fractures on the initial state of stress of earth materials. Results of the former project have been used as an input parameter in the geotechnical design of a section of the Washington subway.

Current research projects include an evaluation, by means of models, of the analytic methods of three-dimensional rock slope stability studies, a preliminary field investigation of geological factors affecting the liquefaction potential of outwash deposits in some midwestern river valleys, and the development of a predictive model of subsidence over areas of partial coal extraction in terms of geology and mining methods.

Dr. Nieto and Caner Zanbak, doctoral candidate, prepare a direct shear device for testing (jointly developed by the Geology and Civil Engineering departments).

ILLINI ACHIEVEMENT AWARD GIVEN

Kenneth O. Emery (B.S., 1937; M.S., 1939; Ph.D., 1941) was chosen this year as one of three alumni recipients of the Illini Achievement Award given by the University of Illinois Alumni Association. The awards were presented at commencement last May 15. Dr. Emery's portrait has been added to the Illini Union gallery of all recipients. The award was established in 1957.

Dr. Emery joined the Woods Hole Oceanographic institution in 1962 where he is now the Henry Bigelow Oceanographer. His principal professional interest in past years has dealt with the continental shelves and adjacent areas, specifically in the China and Java seas, the west coast of Africa, and the eastern coast of the United States. He has attempted to synthesize what is known of these vast areas and to determine what bearing these have on world problems, especially the problem of petroleum reserves.

GEOLOGY PROFESSORSHIP ESTABLISHED

Professor Emeritus Ralph E. Grim has established a fund in the University of Illinois Foundation for a named professorship in geology. The position is to be filled by a person whose interests parallel those of Professor Grim, a clay mineralogist. Eventually the Ralph E. Grim Professorship will become an endowed chair whose occupant will be an expert in sedimentation, industrial minerals, or clay mineralogy.

As a consultant to Union Carbide's Nuclear Division, which is under contract to the U.S. Energy Research and Development Administration, Professor Grim is currently helping to find suitable sites in argillaceous rocks for underground disposal of nuclear wastes and will organize preliminary tests to determine effect of nuclear waste on rocks if they are exposed to the wastes. Professor Grim is also currently involved in clay studies directed at helping to avoid a threatened shortage of aluminum.

SPECIAL AWARDS AND RECOGNITION

Dr. Robert N. Farvolden became dean of the Faculty of Science at the University of Waterloo on September 1, 1977. Dr. Farvolden, a distinguished teacher and researcher in hydrogeology, groundwater resources, water pollution, and waste disposal, was chairman of the Earth Sciences Department from 1970-76. He received his Ph.D. from the University of Illinois and taught here from 1964-69.

Professor P. A. Sandberg, acting head of the Department of Geology at Illinois, was awarded the Outstanding Paper Award for the 1975 Journal of Paleontology by the Society of Economic Paleontologists and Mineralogists at the annual meeting in Washington, D.C., in June 1977.

Dr. William W. Hay has been named permanent dean of the University of Miami's Rosenstiel School of Marine and Atmospheric Science. An internationally known micropaleontologist, Dr. Hay was chairman of marine geology and geophysics and interim dean since June 1976. Dr. Hay received his Master of Science degree from the University of Illinois and taught here from 1960-73. He was recently appointed to the Ocean Sciences Board of the National Research Council.

Professor Robert P. Sharp of the Division of Geological and Planetary Science, California Institute of Technology, has been awarded the Geological Society of America 1977 Penrose Medal. Professor Sharp taught at Illinois from 1938-44.

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DEPARTMENT OF GEOLOGY NEWSLETTER
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MAY 25 1983

To Alumni and Friends of the Department:

This issue of the NEWSLETTER contains articles describing some of our student and faculty research projects: Meteorite impact areas in Brazil, Dr. George White's recent work with the Ohio Survey, and Dr. Hilton Johnson's study to determine the origin of large-scale patterned ground.

In our next issue we plan to present detailed information about the students currently enrolled in our programs, as well as an update on the recruiting and placement activities of the department. Faculty members have been very successful during the past few years in obtaining support for their research projects. Additionally, the department has benefited from several rather significant private contributions through the University of Illinois Foundation. More detailed information about research support and other aspects of departmental funding will appear in the next issue.

We welcome and encourage your input for the NEWSLETTER. Notice of any address changes, new positions, honors or awards, or other information would also be greatly appreciated. Please send the information to the departmental secretary, Ellen Abell.

Philip A. Sandberg
Acting Head

OHIO MAPPING BY PROFESSOR EMERITUS WHITE

Illinois has long been recognized for its work in Pleistocene geology. The strong Pleistocene programs of the Illinois State Geological Survey and at the University of Illinois have long made Urbana a noted center for advanced instruction and research. The current work under Professor W. Hilton Johnson and his students emphasizes the Pleistocene stratigraphy of the Central Interior; it is well known nationally and internationally through many bulletins and journal articles.

Professor George W. White, who came to Urbana in 1947 as professor and department head, became research professor in 1965, and research professor emeritus in 1971, has mainly worked in the rugged, dissected Appalachian Plateau, where the glacial topographic forms and the drift stratigraphy have presented challenging problems. Several of Professor White's students have also worked in this region, but the research areas of the majority of his more than 30 Ph.D. students have been in eastern and especially in western Canada.

Since 1971 Professor White has continued his field and laboratory studies with more and more emphasis on the implication for engineering, water supply, waste disposal, and the environment. Detailed reports and maps of the northwestern Pennsylvania part of the glaciated plateau have been published by the Pennsylvania Geological Survey. Reports on counties in northeastern Ohio have been published beginning in 1953, in part by the U.S. Geological Survey (USGS), and later by the Geological Survey of Ohio in a series of bulletins with finely produced colored maps. General papers have also been published in national and international journals.

With the completion of field and laboratory work and completion of maps and reports of all the 15 counties, a summary map of the whole area has just been completed and will be published by the Ohio Survey. The accompanying text is in preparation. The completion of that four miles to one inch map has been an "interesting exercise" according to Professor White — in order to show details, a magnifying glass and crow-quill pen have been standard tools.

A set of five smaller maps of the whole area shows the position and extent of the three glacial lobes that invaded the plateau at different times in the Wisconsinan Stage. Professor White (and his students up to 1971) can now show the distinctive character of the successive formations of Wisconsinan age in each lobe, and of the pre-Wisconsinan formations, which have been exposed in deep excavations for superhighways and especially in strip mines.

George White, professor emeritus, working on a map for his Ohio mapping project.

The imminent completion of maps and reports of the geology of the plateau in Ohio and Pennsylvania brings to completion work that began in 1949 under the support of the USGS, and later of the National Science Foundation and the Ohio Geological Survey with its excellent editorial and cartographic staff. Actually, the first observations in the plateau were made in 1929 and reported in papers in 1934, but glacial geology at that time was almost entirely morphologic, and any stratigraphy, with its confusion of time and rock terminology, was barely mentioned. It was not until the work began in 1949 that it was realized that tills in the plateau were distinctive, could be traced long distances, and should be treated under the strict rules of the Stratigraphic Code, with clear distinction between time and rock terms. Professor White and his students in the plateau and the members of the Illinois Survey in the Till Plains were among the earliest leaders in this development, which is now standard practice in Pleistocene research.

RESEARCH PROGRAM INITIATED TO DETERMINE ORIGIN OF LARGE-SCALE PATTERNED GROUND

Professor Hilton Johnson has initiated a research program to determine the origin and paleoclimatic significance of large-scale patterned ground, which is widespread in central and eastern Illinois. The patterns, which have been overlooked for years, are most evident on aerial photographs. They are common on the drift plain of the last glaciation (Woodfordian) and extend for some distance south and west of the Woodfordian boundary onto the Illinoian drift plain. The patterns are polygonal in outline and appear to be most similar in shape, size, and occurrence to modern patterns that occur in areas of permafrost. Supporting an ice-wedge polygon origin are a number of vertical wedge-shaped bodies which have been noted near the patterns in several areas and which have characteristics of ice-wedge casts. Thus, both features appear to be relic forms which date from the time of the last glaciation.

Associated with these patterns are a number of highly circular-to-oval landforms. Some of these features are surrounded by low ramparts and others have an air photo tonal pattern which suggest radial tension fractures around a former domal feature. These circular forms resemble pingo scars, although other origins are possible. Pingos also are common landforms in some permafrost areas today.

Considerable controversy exists concerning the Pleistocene climatic conditions in the area where the landforms occur; that is, near the margin of the last glaciation. If a permafrost origin for the features is verified, it will indicate that the periglacial climate was much more severe in this area than most previous work would suggest. The research was initiated last fall, and preliminary results will be presented at the north-central GSA meeting in May.

Professor Johnson is also working with Cathy Hunt (B.S., 1972) of the Illinois State Geological Survey in a geology-for-planning report for Vermilion County; with Dr. James King of the Illinois State Museum on mid-Wisconsinan pollen studies in Illinois; and with several graduate students involved in stratigraphic, sedimentologic, and geomorphic studies of glacial sediments in northern Illinois, north-central Indiana, along the Illinois–Indiana state line and in southwestern Illinois.

ASTROBLEMES STUDIES IN BRAZIL

Impact craters are perhaps the most ubiquitous of planetary landforms; thousands have been detected on all the inner (Terran) planets and their satellites through investigation by telescope or remote probes. However, due to the corrosive surface, only a handful are presently known on the Earth. Utilizing the new information which the recent utilization of satellite technology has supplied to the geologic community, an intensified study of meteorite craters is being conducted at the University of Illinois. A detailed search of worldwide satellite and aviation photography by graduate researcher John McHone has revealed a number of circular patterns thought to be the terrestrial remains of ancient meteorite craters. Two such features were discovered in a remote region of Brazil and were explored by a ground expedition jointly sponsored by the Smithsonian Institution, NASA, and the Brazilian space agency, INPE.

A reconnaissance team consisting of McHone and three Brazilians succeeded in penetrating the twelve km wide Serra da Cangalha structure in northern Goias and the four km diameter Riachao Ring in southern Maranhao. Definite evidence of meteorite impact, in the form of shatterconed boulders, was recovered from the larger site. Shatterconing is a distinct form of target–rock fracturing known only from nuclear experiments and meteorite explosion (high velocity impact) sites. Although similar definitive petrographic evidence of extraterrestrial shock was not detected at the smaller Riachao Ring, the field inspection left little doubt as to the cosmic origin of the second structure. The intense local disturbance of level strata, a chaotic uplifted central area, a collar of fallback breccia, and an absence of extrusive igneous features are all characteristics of known meteorite explosion craters.

John McHone and guide, Ramón, pointing to the Mountain Ring, Serra do Congalha, on uplifted central portion of an ancient meteorite crater.

Inspecting slabs of meteorite explosion breccia, Riachao Ring, Brazil.

The global satellite search has thus far yielded several scores of previously unknown, potential impact sites distributed over all the continents. The correct identification of any terrestrial crater has geologic value ranging from economic exploitation of the feature to elucidation of interplanetary phenomena. The number, distribution, and present appearance of Earth's craters are not completely known, nor are the mechanics responsible for the various forms of craters fully explained. Each new discovery is providing basic information on the most fundamental surface feature found in our solar system.

RHODES NAMED PRESIDENT OF CORNELL UNIVERSITY

Professor Frank H. T. Rhodes was inaugurated as president of Cornell University on November 10, 1977. He began his University of Illinois academic career in 1950 as a postdoctoral fellow and Fulbright scholar, and became a visiting lecturer during the summers of 1951 and 1952. After a time at the University of Durham, he was appointed assistant professor at the University of Illinois in 1954 and promoted to associate professor in 1955.

In 1956, Professor Rhodes went to the University of Wales (Swansea) and was appointed dean of the faculty of science in 1967. Professor Rhodes, in 1968, went to the University of Michigan becoming department head, then dean, and vice-president before becoming Cornell University's ninth president.

PROFESSOR KLEIN, CO-CHIEF SCIENTIST ON LEG 58

Professor George deV. Klein served as co-chief scientist on Leg 58 of the Deep Sea Drilling Project in the Shikoku Basin and North Philippine Sea. Five sites were drilled, primarily to determine basement ages of these basins, paleocirculation, depositional environments, composition of the basaltic basement, and to establish a chronostratigraphic section for the northwest Pacific. In 1973 Professor Klein served as a sedimentologist on Leg 30 in the southwest Pacific.

FULBRIGHT-HAYS AWARDS IN GEOLOGY 1976–1977

The Fulbright-Hays program, for 30 years, has provided opportunities for university lecturing and advanced research abroad. Among the 1976–1977 grants, three of the 11 awards in geology were made to alumni:

Richard A. Davis (Ph.D., 1964), professor and chairman, University of South Florida (Tampa) to the University of Melbourne (Australia), 3/76–9/76 (lecturing and research).

William B. Size (Ph.D., 1971), assistant professor, Emory University (Atlanta, Georgia) to the University of Bergen (Norway), 9/76–6/77 (research and travel).

Ronald P. Willis (Ph.D., 1958), associate professor, University of Wisconsin (Eau Claire) to the University of Benin (Nigeria), 9/76–6/77 (lecturing).

ALUMNI IN THE NEWS

Francis W. Allen (B.S., 1954) has been named director of Technical Services for the Peoples Gas Light and Coke Company, a subsidiary of Peoples Gas Company, Chicago. Allen joined the utility in 1956.

Dr. George V. Cohee (M.S., 1932; Ph.D., 1937) received the AAPG Distinguished Service Award in June 1977. Cohee's professional career began with the Illinois State Geological Survey. In 1943 he began work in the USGS, where he remained except for a time as chairman of the geology department at the University of Arkansas. Cohee retired from the USGS in January 1977.

Raymond C. Gutschick (M.S., 1939; Ph.D., 1942), professor, University of Notre Dame, was the recipient of the 1977 Neil A. Miner Award. This award is symbolic of effective teaching and geologic mental resonance between teacher and students. Gutschick's practical experience before teaching was gained from employment with Mobil and Gulf Oil Companies. Gutschick has been teaching at Notre Dame for 30 years and his current teaching is stimulated by field research of a deep-water Paleozoic basin in Utah.

Sandra J. Lindquist joined the staff of Amoco Production Company (Denver Division) in November 1976. Lindquist received her B.S. here in 1974 and her M.S. from the University of Texas (Austin) in 1976.

Charles H. Norris (B.S., 1969) has joined Tenneco Oil Company in the Gulf Coast Division, Houston, as a senior geological engineer. He received his M.S. in 1970 from the University of Washington (Seattle). Prior to his joining Tenneco Oil Company, Norris was employed by Shell Oil Company and by Amoco International Oil Company.

William A. Oesterling has been appointed chief geologist of Southern Pacific Land Company, with headquarters at San Francisco. Osterling (B.S., 1943; M.S., 1949) joined Southern Pacific in 1957. He was named assistant chief of exploration in 1961 and assistant chief geologist in 1963.

Dr. Sam H. Patterson (Ph.D., 1955) was presented a Meritorious Service Award, the second highest honor bestowed by the U.S. Department of the Interior, at a recent ceremony at the U.S. Geological Survey's National Center in Reston, Virginia. Patterson, a commodity geologist at the national center, "is the survey's principal expert on several economically important mineral commodities and a world authority on bauxite (the ore of aluminum) and clay," the award citation said.

Dr. Owen L. White (Ph.D., 1968) has taken a new position as chief of the Phanerozoic Geology Section, Ministry of Natural Resources in Ontario. His section is responsible for all Paleozoic, Mesozoic, and Quaternary mapping in Ontario as well as more detailed studies on crushed rock, sand, and gravel resources. White hopes to continue a close relationship with the University of Ontario (Waterloo) from which he resigned before taking his new position in March 1977.

Dr. Roy E. Williams (Ph.D., 1966), University of Idaho professor of hydrogeology, has been named to a one-year post as technical advisor to the federal Nuclear Regulatory Commission. Williams will evaluate available technologies and license applications for uranium mining and milling to determine whether proposed waste disposal procedures will prevent environmental degradation. Williams has been a faculty member at the University of Idaho since 1966, but during four of those years has been on leave engaged in various pollution control activities.

Professor Richard A. Yund (B.S., 1956; Ph.D., 1960), professor of geology at Brown University, has been awarded a Senior Scientist Humboldt Award for his work on mineral kinetics and exsolution mechanisms. He will be doing research for a year in Kiel, Germany, starting in late January 1978.

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